The 100th Annual Meeting of the Illinois Section of the Mathematical Association of America

Virtual Meeting
March 12-13, 2021

Speaker and Abstract List

Plenary Talks

Angela Antonou, University of St. Francis
Opening Plenary on Friday, March 12, 1:00 - 1:50
Encouraging and Supporting Undergraduate Research

How often have your math students asked the question "when will I ever need to use this in the real-world?" Modeling, or mimicking, the physical world often starts out by applying some basic principles in physics that uses mathematics as a tool to discovery. This presentation will describe some applications of mathematics applied to very understandable observations that lead to either discovery or invention. Some interesting video examples will be included.

Arden is a founding partner of Natural Science, LLC and the visionary behind the concept of using electromagnetic forces to remediate oil spills in our oceans and waterways. As Principal Scientist of Natural Science, LLC, Arden proved his concept in laboratory settings, envisioned the prototype, and assembled the team of investors, engineers, and scientists to build the companys first product, E-MOPTM Electromagnetic Oil Spill Remediation Technology.

Arden is also an Accelerator Physicist at Fermi National Accelerator Laboratory in Batavia, Illinois, working to advance the science of the Particle Accelerators used in particle physics. He is a frequently published author and public speaker on a range of scientific topics. Arden Completed his undergraduate studies at The City University of New York -City College and Columbia University in Physics and Electrical Engineering respectively before completing his Graduate work in Physics at Stony Brook University.

J. Alan Alewine, McKendree University
Morning Plenary on Saturday, March 13, 9:00 - 9:50
Something for Everyone

In the spirit of inclusivity, this presentation will appeal to students and instructors alike. Included is a teaching tidbit, an interesting proof of a well- known result, and musings on "being in the middle".

About the Author: Alan Alewine hails from South Carolina, where he attended Furman University as an undergraduate. He completed his graduate work in analysis at Vanderbilt University and has been a faculty member at McKendree University since 2002. He has also been an associate provost since 2014 and admits he loves the administrative work! He is wild about roller coasters, having visited 11 amusement parks in 2019. (Steel Vengeance is his favorite coaster.)

Edward Kim, University of Wisconsin - La Crosse
Closing Plenary on Saturday, March 13, 11:00 - 12:00
What does Minesweeper have to do with mathematical proofs?

I have a love-hate relationship with the game of Minesweeper. The game has had negative and positive influences on me as a mathematician. The game almost kept me from becoming a mathematician, yet simultaneously helped turn me into the mathematician I am today. Oddly enough (and amusingly enough), the game has had influences on how I think about proofs, both as a researcher and as a faculty member who regular teaches our foundations/bridges/proofs course.

Through understanding my students' struggles in abstract algebra and combining this with my own experiences when I was starting to become a mathematician, I desired to revisit the concepts of a foundations course from an intuitive lens. Removing esoteric descriptions of proof by cases

gave way to Minesweeper. Reformatting syllogisms for visual clarity allowed students to quickly grapple with the task of proof.

In the most surprising twist, my student plunge into proving a type of theorem which never seems to appear in typical foundations courses, but are extremely typical of theorems they are expected to prove in abstract algebra and real analysis. Moreover, they thoroughly enjoy proving this type of theorem: more than once, I have had students make special requests that a theorem of this type is placed on an exam because they are so fun. Ask a question type that prepares them more thoroughly for algebra and analysis while simultaneously keeping them entertained? That's a win-win!

About the Author: Eddie Kim (he/him/his) is an associate professor at the University of Wisconsin-La Crosse. He studied at UC Berkeley for a B.A. in math (2004) and at UC Davis for a Ph.D. in math (2010) with a focus on geometric combinatorics. His primary hobbies are piano and lindyhop.

Contributed Talks

An asterisk * denotes an undergraduate speaker.

Peter Andrews, Eastern Illinois University
Friday, March 12, 2:00 - 2:25
A Proof of Morley's Theorem Using Complex Analytic Geometry

Morley's Theorem states that, "The points of intersection of the adjacent trisectors of the angles of a triangle are the vertices of an equilateral triangle." This was discovered by Frank Morley in the early 20th century. He mentioned it to friends in Cambridge and published it some twenty years later. In the meantime, it was rediscovered and presented as a problem in the Educational Times. Two solutions were sent in at that time. Since then there have been numerous proofs of this rather surprising result. In this talk I will present a proof (originally due to Alain Connes) using complex numbers and, in particular, their use in the representation of isometries of the plane. The proof involves some tricky but elementary algebra and should be accessible to all who attend.

Joseph Drozek*, Lewis University
Friday, March 12, 3:25 - 3:40
Using Mathematical Models to Predict the Impact of the Coronavirus in the Chicagoland Area

The rapid spread of the novel coronavirus SARS-COV-2 (also known as COVID-19) has created great socioeconomic distress for individuals across the world. A striking number of cases of the SARS-COV-2 coronavirus in the United States, and more particularly the state of Illinois, has highlighted the need to better understand how to reduce its spread while vaccines are distributed. In our paper, we present a compartmental model of COVID-19 transmission using data from the Chicago area. We implement the Ordinary Least Squares Method to help estimate our infection parameters. We introduce quarantine compartments to determine the impact of proper contact precautions on reducing the spread of the virus. From this, we use a combination of the data available to us and the estimated parameters to predict how well different disease prevention scenarios will lower the transmission of the coronavirus. We then perform a rigorous sensitivity analysis of the various parameters involved within the model to determine which, if any, significantly modify our results. The results of our model suggest that a self-imposed quarantine does provide a significant impact on the total infected population.

John Erickson, Erickson Analytics
Friday, March 12, 3:05 - 3:30
Integrating Problem Solving, Coding, Mathematics, and Pedagogy

We will present a case study illustrating an integrated approach to the teaching of problem solving, computation, and mathematics. This approach combines ideas from Polya, Ross, and Moore about mathematical pedagogy with a heavy dose of computer assisted calculation in the spirit of experimental mathematics facilitated by the rapid prototyping environment of Mathematica which is ideal for an exploratory approach to learning. Essentially, students learn math and programming the same way mathematicians do research and we believe that this can scale all the way from grammar school to graduate school. To be more specific, we start with an elementary

recreational math problem called the "last one standing problem". Initially we approach this from a computational and algorithmic perspective. It turns out that its resolution really comes down to a fractal integer sequence: 1, 2, 4, 3, 8, 7, 5, 6, 16,... which is related to the classic error correcting Gray code ordering of the positive integers. Wrestling with the growth of this sequence then led us to the question of how you measure the growth of very messy but not random functions. To address this question, we introduce a family of formulas inspired by linear regression, but in the end, focus on one member of this family which we found particularly difficult but interesting and we carefully document all our various approaches to calculating a growth rate with it. Fortunately, because this integer sequence has an enormous amount of structure, by writing programs and running experiments we were able to uncover many hidden patterns, many of which we were able to formulate as precise mathematical theorems and prove. In particular, we did find a theoretically satisfying and computationally efficient way to calculate the growth rate quantity. Having achieved our goal, this would normally be the end of it: algorithms, programs, and proofs of theorems are the usual "deliverables" for researchers working in computer science and mathematics. In our case however, we regard these results as partly incidental since we really want to highlight the approach used to obtain them, as we believe it provides an accessible example of how to learn, teach, and do research in mathematics.

Libby Heublein*, Arturo Corona*, Mario Viramontes*, and Jake Hutchinson*, Roosevelt University

Saturday, March 13, 10:40 - 10:55

Microplant Project Data Analysis

Over several semesters the Industrial Research Course at Roosevelt University has worked on the Microplants Project in collaboration with biologists at the Field Museum in Chicago. Students at Roosevelt University were tasked to clean and analyze data generated by museum patrons in an interactive exhibit measuring lobules of microplants. This task is being achieved by doing data quality assessments and manipulation with automation of cleaning and analysis using Excel and Python. Threshold criteria for lobule measurements were based on angle measurement, lengths, and data completeness. Age demographic of the museum patrons was also recorded to track the data quality and retention per age group. We will be discussing our process and results to date.

William Mastin*, University of St. Francis

Joint work with Angela Antonou, University of St. Francis

Friday, March 13, 10:20 - 10:35

An Algorithm for Constructing Arbitrarily Large Chains of TriOminos

Consider the game of dominos, played with a set of triangular tiles, with positive integers placed at the vertices rather than dots. Imagine laying this set of tiles out on a table, and attempting to construct a chain of all the tiles, each one being a match to his neighbor. Could such a chain be constructed using every tile in the set? Furthermore, could such a chain be constructed for an arbitrarily large set of tiles? In this presentation, we propose a method for constructing these complete chains of tiles for arbitrarily large sets. We have shown that this is possible for sets of tiles with maximum included digit less than or equal to 5.

Miles Mena*, Lewis University
Saturday, March 13, 10:00 - 10:15
Graph Theoretical Design Strategies for Modeling Self Assembling DNA Complexes

Self-assembly is a term used to describe the process of a collection of components combining to form an organized structure without external direction. The unique properties of double-stranded DNA molecules make DNA a valuable structural material with which to form nanostructures, and the field of DNA nanotechnology is largely based on this premise. By modeling complexes with discrete graphs, efficient self-assembly of nanostructures becomes a mathematical puzzle which can be solved using methods from graph theory and linear algebra. This research shares the results of applying these techniques to Mongolian Tent Graphs.

Jeanette Mokry and Sara Quinn, Dominican University
Saturday, March 13, 10:00 - 10:25
Peer-Led Team Learning in College Algebra

College algebra is a course required for every STEM major at Dominican. As part of the NSF HSI grant Building Capacity: The Dominican University STEM Success Model, since the fall semester of 2019 several sections of college algebra have utilized the Peer-Led Team Learning model of student support. Student peer leaders are embedded in these sections of college algebra. In addition, the peer leaders run mandatory hour-long workshops for students each week. Each semester, students and peer leaders answer questions to help us gauge the level of impact this program has had on their confidence and knowledge of the material. We will share what the role of the faculty is for this Peer-Led Team Learning model as well as some of the questions we will be exploring as we look over data collected thus far.

Emily Olson, Millikin University
Saturday, March 13, 10:30 - 10:55
Writing in a Mathematics Course

The pandemic spurred me to add variety to the types of assessments and engagements that I use in my courses. In this talk, I will describe some writing activities that gave me new insights into how my students view mathematics and their own learning.

Kiah Wah Ong, Illinois Institute of Technology
Friday, March 12, 2:00 - 2:25
Applying Superposition Principle in Solving System of Linear Differential Equations

Most students first encountered generalized eigenvectors in their first course in differential equations. Generalized eigenvectors are used to solve system of linear first-order differential equations with a defective matrix. However, most textbooks at this level do not provide enough insight into why the method works. Instead of discussing Jordan canonical form, an alternative approach will be presented in this talk utilizing mainly the concept of linear dependency and superposition principle.

Christina Pospisil, USA
Friday, March 12, 2:25 - 2:40
Generalization Theory of Linear Algebra III

The talk continues the presentations Generalization Theory of Linear Algebra I+II from JMM 2019 and JMM 2020. In the first part an algorithm for multiplying matrices regardless of dimensions via an embedding and inverses for non-injective mappings in one dimension were presented (first part was presented at JMM 2019). The second part presented inverses for non-injective mappings in one and multiple dimensions and introduced a general determinant theory (second part was presented at JMM 2020). The third part is dedicated to a further generalization regarding tensors with first applications in physics. In future work there will be further operations and applications to physics and other natural sciences be explored. JMM = Joint Mathematics Meeting

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Rachel Rupnow, Northern Illinois University
Friday, March 12, 2:30 - 2:55
Structure-Preservation: What Are We Talking About?

Structure-preservation and operation-preservation are common ways to refer to the homomorphism property in algebra and to similar morphisms in other branches of mathematics. However, it is not always clear what mathematicians mean by these terms, nor is it clear what students take away from these terms. Based on interviews and surveys from mathematicians and abstract algebra students, this talk examines how "structure-preservation and "operation-preservation are used in mathematics, especially in abstract algebra, and how these terms ambiguity can mask miscommunication.

Sydney Smith, Hawkes Learning
Friday, March 12, 3:05 - 4:00
Step-By-Step Software-Guided Calculus & Statistics Problem Solving

Explore Hawkes mastery-based homework & testing software, featuring over 43,000 unique algorithmically generated question iterations and the powerful LaTeX-based Question Builder tool, allowing instructors to create their own questions! Discover how software can provide pinpointing, error-specific feedback, recognize alternative equivalent answers, and teach students through interactive step-by-step problem-solving tutorials with detailed explanations of the solution process. Save time with automated grading and receive detailed analytics on question-based performance, time on task, and assignment completion to track student success and intervene at crucial learning points. Learn about other Calculus and Statistics resources, including short example videos, concept overview videos, and immersive and challenging chapter projects based on real-world applications of course material. All attendees will be entered to win one of three $25 Amazon gift cards!

Ethan Thieme*, Raman Aliakseyeu*, and Natalie Oliven*, Benedictine University
Friday, March 12, 2:45 - 3:00
Counting the Generalized and Extended Symmetric Spaces of $SO(3, \mathbb{F}_q)$

In this presentation we will provide a count for the size of both the generalized and extended symmetric spaces of $\mathrm{SO}(3, \mathbb{F}_q)$ for all involutions when the characteristic is not equal to two. In

addition we will explicitly describe the elements in the extended symmetric space and the fixed point group for both involutions.

Melanie Tian*, Lake Forest College
Joint work with Enrique Treviño, Lake Forest College
Friday, March 12, 3:45 - 4:00
Generalizing Parking Functions with Randomness

In our first generalization, when a cars preference spot is taken, we ask it to flip a fair coin to decide whether to go forward or backwards to check for the next available spot to park. We obtained the expected value of number of preferences that every car parks. In our second generalization, we generalize k-Naples parking as we ask each car to flip a coin with probability p for first going backwards and $1-p$ for going forward to decide whether to first go backwards or not. We obtained a recursive formula for the expected value of number of preferences that every car parks. Also we delightfully found when $p = 1/2$ and $k = 1$, having probability $t/2^{n-1}, t \in \{0, 1, ..., 2^{n-1}\}$ for every car to park all have at least 1 preference satisfying, and when t is odd, there is exactly 1 preference.

Enrique Treviño, Lake Forest College
Friday, March 12, 2:30 - 2:55
On sets whose subsets have integer mean

We call a finite set of positive integers balanced if all its subsets have integer mean. For a positive integer N, let $M(N)$ be the cardinality of the largest balanced set all of whose elements are less than or equal to N, and let $S(N)$ be the cardinality of the balanced set with elements less than or equal to N that has maximal sum. We study properties of balanced sets and answer questions regarding what positive integers N satisfy $M(N) = S(N)$.

Megan Vesta*, Lewis University
Friday, March 12, 3:05 - 3:20
A Markov Chain Model For Predicting College Baseball

Ranking sports teams can be a challenging task, and using straight win percentage can be misleading at times. Among the many mathematically inspired sports ranking systems, linear algebra methods are among the most elegant and simple. In this research we focus on applying a Markov chain method to predict the future results of NCAA Division 1 College Baseball. In particular we investigate whether win streaks can help predict the final standings for college baseball.

Marshall Whittlesey, California State University San Marcos
Saturday, March 13, 10:00 - 10:25
Using quaternions to prove theorems in spherical geometry

It is well known that the complex numbers can be used to do transformation geometry in the plane. In particular, rotation by angle θ about the origin is accomplished via multiplication by the complex number $e^{i\theta} = \cos(\theta) + i\sin(\theta)$. It is less well known that the quaternion algebra can be used to do similar transformations in three dimensional space. In this talk we show how to use quaternions to prove an interesting classical theorem in spherical geometry. These methods are featured in the speaker's new book with CRC Press, "Spherical Geometry and its Applications", which the author hopes will be attractive for use in topics courses in geometry.

Aaron Zerhusen, Dominican University
Saturday, March 13, 10:30 - 10:55
One Example of Social Justice In a Statistics Class: Bill Jenkins and the Tuskegee Experiment

The long-running Tuskegee Study is infamous in the history of medicine in the United States as an example of unethical practice and racism. In this talk, we will look at an overview of the study, and focus on one of the sole voices to speak out against it, a young statistician named Bill Jenkins. The eventual outcry against this and other experiments helped lead to the modern institutional review board. We will then discuss how I used his story within a introduction to statistics classroom. Content note: this talk will discuss race and racism in recent US history, as well as sexually transmitted diseases.